

ARKANSAS-WHITE-RED RIVER BASINS

A Report on the Conservation and  
Development of Water and Land Resources  
Prepared by Federal and State Agencies  
Under Authorization of Section 205 of  
the Flood Control Act of 1950.

Part I

This volume comprises Part I of the Report of the Arkansas-White-Red Basins Inter-Agency Committee, which was organized by direction of the President to conduct a comprehensive survey of the water and related land resources of the Arkansas, White, and Red River Basins, as authorized in Section 205, Public Law 516, 81st Congress, Second Session. The complete report consists of two parts:

Part I - An over-all summary of the survey.

Part II - Details of studies on various phases of the survey, subdivided into the following sections:

1. Population, Labor Force, Manufacturing, and Health
2. Water Resources Project Data
3. Flood Control, Waterflow Retardation, and Flood Forecasting
4. Navigation
5. Drainage
6. Irrigation and Reclamation
7. Hydroelectric Power Development and Utilization
8. Domestic and Industrial Water Supply
9. Water Pollution Control
10. Mosquito Control and Allied Problems
11. Agriculture
12. Fish and Wildlife
13. Recreation
14. Mapping
15. Hydrologic Data Collection Program
16. Minerals and Geology
17. Availability, Use, and Control of Water

I - INTRODUCTION

This report of the Arkansas-White-Red Basins Inter-Agency Committee presents a long-range plan for the development of the water and related land resources of the Arkansas, White, and Red River Basins. Part I of the report presents a summary of the framework plan for the three Basins as a whole. Detailed data are contained in Part II, consisting of 17 separate sections arranged by functions as shown on page i.

The authorization for the report is contained in Section 205 of the Flood Control Act of 1950 (Public Law 516, 81st Congress, 2d Session, approved May 17, 1950). Pertinent provisions of the act are as follows:

"AN ACT"

"Authorizing the construction, repair, and preservation of certain public works on rivers and harbors for navigation, flood control, and for other purposes."

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress Assembled."

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"TITLE II - FLOOD CONTROL"

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"Sec. 205. The Secretary of the Army is hereby authorized and directed to cause preliminary examinations and surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its Territorial possessions, which include the following-named localities, and the Secretary of Agriculture is authorized and directed to cause preliminary examinations and surveys for runoff and waterflow retardation and soil-erosion prevention on such drainage areas, the cost thereof to be paid from appropriations heretofore or hereafter made for such purposes: Provided, That after the regular or formal reports made on any examination, survey, project, or work under way or proposed are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law except that the Secretary of the Army may cause a review of

any examination or survey to be made and a report thereon submitted to Congress if such review is required by the national defense or by changed physical or economic conditions: And provided further, That the Government shall not be deemed to have entered upon any project for the improvement of any waterway or harbor mentioned in this title until the project for the proposed work shall have been adopted by law:"

\* \* \* \* \*

"Arkansas, White, and Red River Basins, Arkansas, Louisiana, Oklahoma, Texas, New Mexico, Colorado, Kansas, and Missouri, with a view to developing comprehensive, integrated plans of improvement for navigation, flood control, domestic and municipal water supplies, reclamation and irrigation, development and utilization of hydroelectric power, conservation of soil, forest and fish and wildlife resources, and other beneficial development and utilization of water resources including such consideration of recreation uses, salinity and sediment control, and pollution abatement as may be provided for under Federal policies and procedures, all to be coordinated with the Department of the Interior, the Department of Agriculture, the Federal Power Commission, other appropriate Federal agencies and with the States, as required by existing law: Provided, That Federal projects now constructed and in operation, under construction, authorized for construction, or projects that may be hereafter authorized substantially in accordance with reports currently before or that may hereafter come before the Congress, if in compliance with the first section of an Act entitled 'An Act authorizing the construction of certain public works on rivers and harbors for flood control, and other purposes', approved December 22, 1944 (58 Stat. 887), shall not be altered, changed, restricted, delayed, retarded, or otherwise impeded or interfered with by reason of this paragraph."

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Following passage of the 1950 Flood Control Act, the President on May 19, 1950, sent letters to the Departments of the Army, Agriculture, the Interior, and Commerce, and to the Federal Security Agency and the Federal Power Commission directing that the investigations for the Arkansas, White, and Red River Basins be conducted on an inter-agency basis. The letter is as follows:

"I have signed H. R. 5472, the River and Harbor and Flood Control Act of 1950. In addition to a large number of flood control and navigation projects, many of which are themselves multiple-purpose in character, this Act makes special provision for a comprehensive survey of the Arkansas, White and Red River Basins in the States of Arkansas, Louisiana, Oklahoma, Texas, New Mexico, Colorado, Kansas and Missouri. The Act contemplates the preparation

of a report to provide for the best development and use of the water and land resources of these river basins which comprise 177 million acres - almost 1/11 of the land area of the United States - with a topography and climate varying from the mountains on the west to the coastal plains on the east, and from arid high plains to humid backwater areas of the Mississippi.

"The procedure authorized by the Act is in lieu of a special study commission included in earlier versions of the bill, which would have been preferable. It is significant, however, that for the first time there is specifically recognized in legislation of this type the need for a broad-scale study of the multiple uses of the land and water resources of a river basin. It is essential that the Executive agencies organize their efforts to realize, as far as possible under existing law, the potentialities of the broad-scale, integrated national resources study for the Arkansas, White and Red River Basins authorized in H. R. 5472.

"In this connection it is important that the efforts of the various agencies be integrated from the very beginning of the investigation. I am sure that you will agree with me that our experience in river basin investigations demonstrates the importance of integrating the activities of the various agencies starting with the planning of the investigation itself. For the purpose of conducting this survey, I am, therefore, requesting that as a first step the various Federal agencies concerned, including your Department, organize an inter-agency committee, formulate procedure, and map out a joint plan of investigation, indicating specifically the precise responsibilities of each and the prospective allocation of agency resources to the joint effort.

"Because of the language contained in H. R. 5472, it seems desirable that the Department of the Army be designated as the Chairman agency. Each agency would, of course, make its contribution in accordance with its responsibilities under existing laws. The final product of such a joint inter-agency investigation should be a single comprehensive report embracing the coordinated views of all agencies concerned.

"I assume that each participating agency and the group as a whole will coordinate its plans and activities with those of the interested States. It is essential that the Federal agencies draw upon the experience and ideas of the people of the area to the fullest extent, and the final report should carry the concurrence or comments of each affected State.

"As I see it, such a joint effort does not involve additional authorizations but instead coordination to the maximum extent under existing circumstances of already authorized activities. It is my desire that the survey be undertaken as soon as

practicable and carried forward in fiscal year 1951 using available funds. The 1952 budget estimates of each agency should be prepared with this in mind and would reflect your planning in accordance with the intent of the Congress."

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In response to the President's letter, the Federal Inter-Agency River Basin Committee (hereinafter referred to as FIARBC) met in Washington, D. C., on June 12, 1950, and passed a resolution establishing the Arkansas-White-Red Basins Inter-Agency Committee (hereinafter referred to as the AWRBIAC) with Federal agencies participating to be the same as on the FIARBC. The purpose of the Inter-Agency Committee was stated as being "to implement the policies and purposes of the Federal Inter-Agency Agreement dated December 29, 1943, by providing a means through which the field representatives of the participating Federal agencies may effectively interchange information and coordinate their activities among themselves and with those of the States in the investigation and preparation of report covering the water resources and related land resources of the Arkansas, White, and Red River Basins."

Initially, Federal representatives were named to the AWRBIAC by the Departments of the Army, the Interior, Agriculture, and Commerce; and by the Federal Security Agency and the Federal Power Commission. In 1953 the representative of the Federal Security Agency was redesignated as the representative of the Department of Health, Education, and Welfare. During the same year the Department of Labor was added to the membership. Prior to the first meeting of the Committee, invitations to participate in its work were extended to the governors of the eight AWR States of Colorado, New Mexico, Kansas, Oklahoma, Texas, Missouri, Arkansas and Louisiana. Each of these governors subsequently appointed a representative to act for him on the Committee and to coordinate the AWR activities of his State. These representatives participated on an equal basis with the members representing the Federal agencies. In March of 1954 the President appointed Mr. Walter L. Huber to the staff of the Executive Office for the purpose of serving as Presidential Adviser on AWR matters.

Throughout the study, the States participated actively with the Federal agencies in developing the plan. The governors' representatives provided valuable assistance and counsel in coordinating AWR planning with the laws, policies, and objectives of their respective States and arranged for participation by the appropriate State agencies. Reference is made to Table 1 for the names and tenure of office of each person who was designated as a State or Federal representative on the AWRBIAC during the preparation of the report.

The Committee held its first meeting on July 28, 1950. Throughout the survey, the Committee met regularly, for the most part at one or two month intervals. Most of the meetings were held in Tulsa, Oklahoma, although at least two meetings were held in each participating State. Some of the meetings were open to the public and provided opportunity for residents of the area to keep informed concerning Committee activities. The actions of the Committee are recorded in official minutes.

Early in the survey the Committee conducted a series of public hearings for the purpose of providing all interested individuals an opportunity to express their views on developments needed in the area. Seventeen hearings were held at 15 locations in the regions. The locations were selected so as to minimize travel for the public. Complete transcripts of the hearings are on file with the participating agencies.

In proceeding with the survey and formulation of the plan for the AWR Basins, the Inter-Agency Committee encountered a number of problems that do not ordinarily confront an individual agency in developing plans for specific functions in a more limited area. These problems arose because of several factors, including (1) the "long-range" nature of the plan; (2) the enormous size of the area and its wide diversity of resources, potentialities for development, and resource problems; (3) the large number of elements requiring consideration and coordination; (4) the many different, sometimes competing purposes to be served by the same resources; (5) the existence of resources plans and programs in various stages of development and operation when the survey was initiated; (6) the number of agencies, both State and Federal, operating under somewhat different laws and policies that had interests and responsibilities in connection with the survey; and (7) the absence of a uniform national policy governing resource development planning.

Individual Federal agencies had established procedures and policies for formulating projects and programs relating to the functions with which they were concerned. Prior to the initiation of the AWR survey the FIAREC had developed some procedures for the evaluation of water use and control projects, and on December 31, 1952, the Bureau of the Budget, in Circular A-47, subject: "Reports and Budget Estimates Related to Federal Programs and Projects for Conservation, Development or Use of Water and Related Land Resources," issued criteria related to the analysis of water resources projects. Although the AWRBIAC adopted the procedures and practices developed by the FIAREC and the criteria set forth in Budget Bureau Circular No. A-47, there was considerable difference of opinion regarding the application of the principles involved and their applicability to long-range planning.

The specific issues confronting the AWRBIAC, the manner in which each of them was met, and the influence these issues had on the plan set forth in this report are outlined in the paragraphs which follow.

The first problem that required the consideration of the individual agencies and the Inter-Agency Committee was that of adopting suitable organizational arrangements for carrying on the survey. Each Federal agency had to establish special procedures for conducting AWR survey activities because agency areal and regional boundaries did not coincide with the boundaries of the AWR Basins. For some agencies the investigations necessitated by the survey differed in nature and scope from those normally undertaken. The State agencies faced somewhat similar problems. The AWRBIAC was required to establish an organization and procedures designed to assure day-to-day coordination of effort among the large number of participating agencies.

As a first step toward accomplishing this objective the Committee established 17 "work groups". The work groups and the representation on each are shown in Table 2. Each work group was concerned with a particular aspect of the survey, such as navigation, drainage, agriculture, fish and wildlife, etc. All State and Federal agencies interested in the activities of a particular work group were members thereof. The agency designated by the AWRBIAC as chairman for a work group was assigned responsibility for obtaining coordination of the activities of all member agencies relating to that aspect of the survey. This responsibility was discharged through meetings of all members of a given work group, through informal conferences of agency representatives, and by organization of subgroups for special purposes or particular areas. Each governor's representative was designated by the Committee as a State Coordinator with the mission of facilitating coordination among the work groups on the studies pertaining to his State.

As the survey proceeded it was recognized that investigations and plans for navigation, drainage, irrigation, flood control, municipal and industrial water supply, and hydroelectric power development were so closely interrelated that additional arrangements were required for coordination of these aspects of the survey. In response to this need, the Committee organized several water use and control groups composed of appropriate representatives of State and Federal agencies. Each group was concerned with a particular geographic area and operated under the chairmanship of a State representative.

In order to provide staff assistance on matters of general concern, the Committee established the Tulsa Group composed of representatives of each Federal agency and each State that wished to participate. This group proposed schedules for Committee

operation, prepared analyses of problems, formulated recommendations relating to the conduct of the survey, and took action in the Committee's behalf on routine matters. Plate 2 is a diagram of the inter-agency organization.

During the course of the survey it became desirable to clarify the responsibilities of the Committee as a whole in comparison with the responsibilities of the participating agencies. The resulting delineation recognized that each agency could conduct and assume responsibility for only such studies and investigations as came within the scope of its interest and responsibility under existing law. Therefore, the Committee as a whole could only assume a responsibility for coordination of the activities of one agency where they impinged upon or overlapped the activities of another. This included the developing of procedures to apply in preparation of the plan, the conducting of joint studies and investigations, and agreeing on the form, scope, content, and schedule for the report.

In considering what was meant by a long-range plan the Committee decided that the plan should include all elements that can be justified for initiation by 25 years after submission of the report. Each element (such as a water use and control project) should be designed to take into account needs which are expected to develop by the year 2000. Recognizing that factors which determine the economic feasibility of projects will change and that standards of feasibility are subject to modification, numerous projects are included in the long-range plan which are not currently feasible. Inasmuch as the conditions that determine whether a given project may prove desirable at some future date are difficult to evaluate, the plan includes those projects and programs considered by Federal and State representatives to warrant inclusion in the framework plan on the basis of the current economic evaluations and the judgement of the planning agency having primary responsibility. Accordingly, it is expected that some of the projects included in the plan that are not economically feasible at this time may become feasible in the future, while others may never warrant development.

The Committee took several steps designed to assure comparability of approach among the agencies in formulation of the long-range plan. Among these was the adoption of assumptions as to the general economic outlook for the three basins. First, it was agreed that a moderate rate of population growth in the three basins would be assumed. The specific estimates of future population are set forth in Section 1 of Part II entitled "Population, Labor Force, Manufacturing and Health." Second, it was agreed that a relatively high level of employment characteristic of an expanding economy would be assumed. Finally, it was decided that projected prices furnished by FIAREC would be used in benefit and

cost analyses. These projected prices were computed by applying certain projected price indices. For construction costs an index of 180 was used (1939=100); for agricultural products an index of 215 was used (1910-14=100). The corresponding indices for the year 1950 are 217.5 and 256, respectively. Where projected prices are not used in the report, the price base is indicated.

In the calculation of benefits and costs it was agreed to follow generally the principles contained in the report of the Subcommittee on Benefits and Costs of the FIARBC entitled "Proposed Practices for Economic Analysis of River Basin Projects." With minor exceptions, the provisions of Bureau of the Budget Circular A-47 were adopted by the Committee. However, because of the differing views as to the applicability of these two guides to long-range planning, the principles, procedures, and practices set forth therein were applied largely in accordance with individual agency policies and interpretations. Difficulties that were encountered in their application are described below.

In view of differences of opinion as to how secondary benefits should be calculated it was decided by FIAREC that "an arbitrary factor of 10 percent would be applied to the value of the increase in agricultural products sold by the farmer, to the value of the increase in power at the load center and to the value of the increase in other project products or services at comparable points as an approximation of the secondary benefits creditable to a project." For hydroelectric power secondary benefits were not to be used to justify a project. In the case of project products or services other than agricultural products and power, the Committee decided that the 10 percent factor would be applied to the primary benefits. No secondary benefits are included in the monetary values of increased production attributable to the treatment of crop, range, and forest lands.

For evaluating hydroelectric power benefits the Committee agreed that power values should be determined in accordance with the procedures embodied in an agreement among the Department of the Interior, the Department of the Army, and the Federal Power Commission, dated March 12, 1954. This agreement provides that, in the economic analysis of hydroelectric power projects, the costs are to be based on Federal financing, but that the taxes foregone by reason of Federal development are to be considered as additional economic costs of the hydro project. Benefits were evaluated on basis of the cost of alternative privately financed fuel-electric generators.

For several reasons, it was difficult to apply the principle of benefit-cost analysis whereby each increment added to a project should have a benefit in excess of its cost. First, because of the long-range nature of the plan, it was impossible to

determine what is a feasible increment of a project no portion of which is presently feasible but which may become feasible at some future date. Second, many projects were not studied in sufficient detail to make such a determination. Third, opinion differed as to the amount of weight that should be given to those factors which cannot be evaluated in monetary terms in deciding whether a given increment of a project is feasible. For these reasons the "incremental principle" was not generally applied in the AWR study.

The Committee considered what policies relating to financing, division of responsibility among levels of government and private individuals, and similar matters should govern the development or undertaking of elements included in the plan. It was assumed that the division of activity in resources conservation and development would continue generally to follow established patterns. Since the Federal agencies were directed to conduct the survey, projects and programs that might be undertaken by Federal agencies are presented in greater detail than projects and programs that traditionally have been primarily the concern of States and private enterprise. At the same time it was recognized that any of the projects and programs included in the plan might be undertaken by the Federal Government, the States, or private enterprise. Reimbursement and cost sharing requirements, where shown, are based generally upon the policies of the agencies that investigated and formulated the project or program.

In a number of areas questions arose as to which of two or more alternative ways should be selected for the development and utilization of a given resource. For example, there were questions as to the extent to which water should be retained in small reservoirs for upstream purposes and the extent to which the supply should be impounded in larger reservoirs for downstream purposes. Similarly, there were questions as to whether certain lands should be drained for agricultural purposes or left undrained and devoted to forestry and wildlife purposes. For the most part, the Committee did not endeavor to resolve issues of this nature. Where the correct answer seemed apparent to all concerned, a selection was made but where there was a question as to what the answer should be, both alternatives are set forth in the report with the understanding that such decisions should be left until the time for development is at hand and more detailed analyses of the specific issues can be made in light of then current conditions. For some areas where only one plan is presented it is recognized that further study may indicate alternative plans not yet investigated to be more desirable.

Throughout the survey, the Committee was faced with the question of the degree of detail that should be sought in the investigation and planning of projects and programs and the extent to which related elements of the plan should be coordinated.

The Committee recognized that, in formulating a long-range plan, it was setting forth a general framework which would be subject to revision as conditions change. Accordingly, it was agreed that detailed study and coordination of the many projects and programs that may not become feasible and desirable for some time would be an unwarranted expenditure of public funds. On the other hand, it was the objective of the Committee to attain a high degree of detail in the study and coordination of those projects and programs found to be economically feasible and warranting early development. Although this objective was not fully realized, this report identifies as Category I proposals certain types of projects and programs considered by the investigating agency to warrant early development. The designation of categories does not signify relative priorities among various projects and programs within the same category; nor does it imply the relative standing between types of projects and programs that have been designated by categories and those that it has not been practicable to classify in that manner. Furthermore, it is recognized that projects and programs not now included in Category I may become desirable for early initiation and that, as a result of further study or changed conditions, it may be found advisable to delay initiation of certain projects and programs now classified in Category I. Other aspects of the problem of achieving an adequate degree of detail in investigation and coordination are discussed below.

For many years prior to initiation of the AWR survey, both State and Federal agencies had programs of investigation and development under way. Some plans had been formulated and were being carried out. A large number of water use and control projects had been planned, many of which had been authorized by the Congress while others had been recommended for development. State and Federal resource agencies such as the game and fish commissions, the State park agencies, the agricultural agencies, the health departments, and others had going programs that related to specific phases of the AWR survey. Accordingly, data and plans developed as a result of previous studies were utilized wherever practicable. Much of the information included in this report is based upon those studies.

In the Flood Control Act of 1950, specific reference was made to the projects that had been previously authorized or recommended. The Act stated, in part, that such projects ". . . shall not be altered, changed, restricted, delayed, retarded, or otherwise impeded or interfered with by reason of this paragraph." The Committee agreed that restudy of any authorized or previously recommended project would be made only upon request of an affected State or agency primarily concerned, and when sound preliminary information submitted to AWRBIAC indicated that the restudy was justified. For purposes of inter-agency coordination the authorized and recommended projects have been considered as projects

in being and have not been subjected to reanalysis, re-evaluation and approval by the AWRBIAC. However, certain changes in those projects resulting from further study by the sponsoring agencies are reflected in this report. In some cases the project was excluded from the plan because of changed conditions.

To achieve a degree of comparability in the economic evaluation of water use and control projects, the Committee sought to assure utilization of comparable basic agricultural data (estimates of crop yield, assumptions as to land use patterns, etc.) by all planning agencies. A special inter-agency group was designated to review agency data and seek adjustments that would assure comparability and sound conclusions. Although satisfactory results were achieved in a few areas, so many problems were encountered that it was decided that in the remaining areas each agency would utilize the data that it had previously developed. Consideration was also given to the desirability of establishing uniform criteria governing the design of water use and control projects because cost estimates are closely associated thereto. However, it was decided that each agency should utilize its own design criteria.

The Committee adopted several measures having the objective of achieving a satisfactory degree of hydrologic coordination of related water use and control projects. Early in the survey a subcommittee was designated to prepare a general inventory of the water resources and compile a record of streamflows at selected locations. Later an inter-agency group of hydrologists under a full time chairman was designated to facilitate the hydrologic coordination of elements of the plan. The Committee also sponsored a special study of a small tributary area in an effort to develop comparable hydrologic and economic procedures to be used by all agencies.

In formulating the framework plan for water use and control it was evident that hydrologic coordination with upstream developments would be needed for all projects contemplating the use or control of substantial quantities of water from surface sources. For projects or programs not contemplating use or control of substantial quantities of water or those in locations where there were no related projects or programs, the hydrologic relationship with other projects and programs was relatively insignificant and could be ignored. For numerous elements of the plan, detailed hydrologic coordination was not warranted because the projects were not justified for early development. All water use and control projects (except where alternatives are specifically designated) have been fitted together hydrologically and economically to the extent that most overlaps in claimed benefits have been eliminated. Yet certain problems remain. Because of differing methods of approach and insufficient data to arrive at conclusive results, agreement was not reached in estimating the effects of

various projects and programs upon total runoff and peak flows. Accordingly where interrelationships are significant, further investigations are required to provide a basis for achieving hydrologic and economic coordination prior to development. Section 2 of Part II, "Water Resources Project Data," sets forth the hydrologic and economic coordination needed for those projects which individual planning agencies have identified as warranting early consideration for development.

As a result of the survey and the action taken on the foregoing issues, a framework plan is set forth in this report that the participating agencies consider as indicating the resource development potentials of the Arkansas, White and Red River Basins. The elements included in the plan are the proposals of the Federal and State agencies, formulated in accordance with agency policies and procedures and adjusted to varying degrees through coordination by the AWRBIAC. For the most part projects formulated prior to the AWR survey have been included in the plan with little change as a result of the survey. Many elements of the plan have received only preliminary study whereas others have been studied in considerable detail. Although alternative projects have been studied, there has not been opportunity to explore all potential alternatives. Many elements set forth herein are not currently feasible according to present standards. Some of them will probably become feasible in the years ahead, whereas others may never warrant development. In certain tributary areas where there are significant interrelationships among elements of the plan, further study will be required before development is undertaken in order to achieve adequate hydrologic and economic coordination. In some cases such studies may indicate that complete reformulation of the plan for the tributary area will be necessary in order to obtain optimum benefits. In other cases only minor adjustments should be necessary.

Accordingly, the Committee visualizes the report as constituting a general guide to the future development of the resources of the area. The resources are identified, their potentialities are appraised, and a framework plan for their conservation and development is set forth. In the years ahead, it is anticipated that those responsible - the States, the Federal Government, private individuals and organizations - will develop more detailed plans for individual elements in the light of information and conditions current at that time, will coordinate such plans with all interested parties, and will take the steps necessary to proceed with their development.

Table 1 - The Arkansas-White-Red Basins  
Inter-Agency Committee

FEDERAL	BASIN REPRESENTATIVES	
	Governor	Governor's Representative
<u>Presidential Adviser</u>		<u>Louisiana</u>
Mr. Walter L. Huber March 1954-June 1955	Hon. Earl K. Long July 1950-April 1952	Col. J. Lester White August 1950-May 1952
<u>Department of the Army Chairman Agency</u>	Hon. Robert F. Kennon May 1952-June 1955	Mr. Roy T. Sessums June 1952-June 1955
Col. Louis W. Prentiss July 1950-May 1952		<u>Missouri</u>
Gen. Herbert D. Vogel June 1952-August 1954	Hon. Forest Smith July 1950-Dec. 1952	Mr. John M. Dewey August 1950-June 1955
Col. L. E. Seeman Sept. 1954-June 1955	Hon. Phil M. Donnelly Jan. 1953-June 1955	
		<u>Arkansas</u>
<u>Department of the Interior</u>	Hon. Sid McMath July 1950-Dec. 1952	Mr. D. D. Terry August 1950-June 1953
Mr. C. L. Forsling July 1950-June 1953	Hon. Francis Cherry Jan. 1953-Dec. 1954	Mr. Arthur M. Emmerling July 1953-April 1955
Dr. C. W. Seibel July 1953-June 1955	Hon. Orval E. Fautus Jan. 1955-June 1955	Mr. Leonard N. White May 1955-June 1955
<u>Department of Agriculture</u>		<u>Texas</u>
Mr. John A. Short July 1950-June 1953	Hon. Allan Shivers July 1950-June 1955	Col. E. V. Spence August 1950-Jan. 1951
<u>Department of Commerce</u>		Mr. A. P. Rollins Feb. 1951-Nov. 1954
Mr. Gustav E. Larson July 1950-June 1953		Col. John J. Ledbetter Dec. 1954-June 1955
Mr. J. A. Elliott Sept. 1953-June 1955		<u>Kansas</u>
<u>Department of Labor</u>	Hon. Frank Carlson July 1950-Dec. 1950	Mr. George S. Knapp August 1950-Dec. 1950
Mr. Ed McDonald June 1953-June 1955	Hon. Edward F. Arn Jan. 1951-Dec. 1954	Mr. R. V. Smerha Jan. 1951-June 1955
	Hon. Fred Hall Jan. 1955-June 1955	
		<u>Colorado</u>
<u>Department of Health, Education and Welfare</u>	Hon. William Lee Knous July 1950-Dec. 1950	Judge Clifford H. Stone* August 1950-Oct. 1952
Mr. E. C. Warkentin July 1950-June 1955	Hon. Dan Thornton Jan. 1951-Dec. 1954	Mr. Ivan C. Crawford March 1953-June 1955
	Hon. Edwin C. Johnson Jan. 1955-June 1955	
<u>Federal Power Commission</u>		<u>Oklahoma</u>
Mr. Wilbur F. Fairbank July 1950-Dec. 1954	Hon. Roy J. Turner July 1950-Dec. 1950	Mr. Clarence Burch August 1950-June 1951 Jan. 1953-June 1955
Mr. Carl E. Roberts Jan. 1955-June 1955	Hon. Johnston Murray Jan. 1951-Dec. 1954	Mr. W. K. Graham July 1951-Dec. 1954
	Hon. Raymond Gary Jan. 1955-June 1955	
		<u>New Mexico</u>
	Hon. Thomas J. Mabry July 1950-Dec. 1950	Mr. John H. Bliss August 1950-June 1955
	Hon. Edwin L. Mechem Jan. 1951-Dec. 1954	
	Hon. John E. Simms, Jr. Jan. 1955-June 1955	

\*Deceased

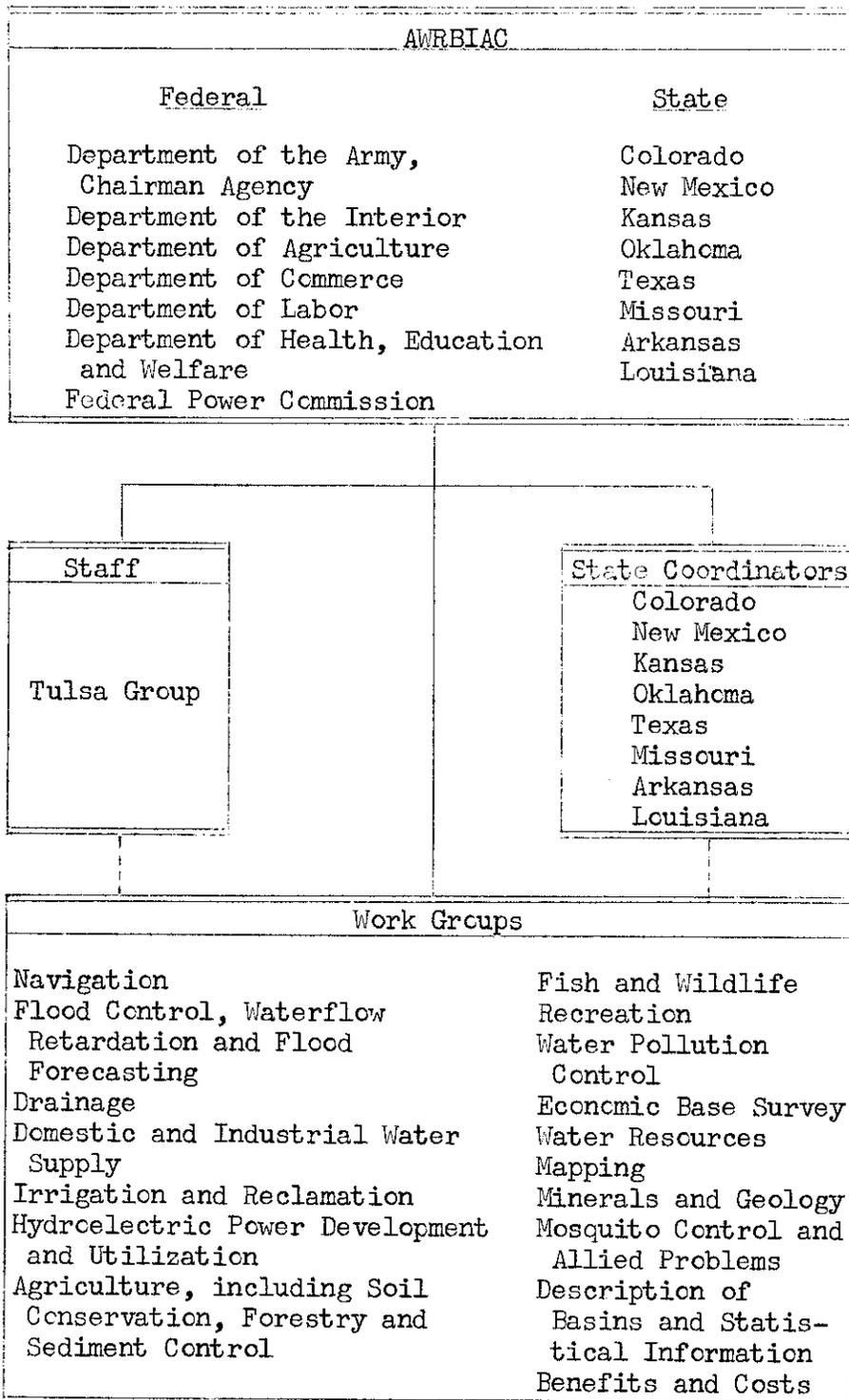
TABLE 2 - WORK GROUP ORGANIZATION

WORK GROUP	FEDERAL						STATE								
	Department of the Army	Department of the Interior	Department of Agriculture	Department of Commerce	Department of Labor	Department of Health, Education and Welfare	Federal Power Commission	Louisiana	Missouri	Arkansas	Texas	Kansas	Colorado	Oklahoma	New Mexico
Navigation	(X)	X		X		X	X	X	X	X	X	X	X	X	X
Flood Control, Water-flow Retardation and Flood Forecasting	(X)	X	X	X		X	X	X	X	X	X	X	X	X	X
Drainage	(X)	X	X			X	X	X	X	X	X	X	X	X	X
Domestic and Industrial Water Supply	(X)	X	X	X		X	X	X	X	X	X	X	X	X	X
Irrigation and Reclamation	X	(X)	X			X	X	X	X	X	X	X	X	X	X
Hydroelectric Power Development and Utilization	X	X	X			(X)	X	X	X	X	X	X	X	X	X
Agriculture, Incl. Soil Conservation, Forestry and Sediment Control	X	X	(X)			X		X	X	X	X	X	X	X	X
Fish and Wildlife	X	(X)	X			X		X	X	X	X	X	X	X	X
Recreation	X	(X)	X			X		X	X	X	X	X	X	X	X
Water Pollution Control	X	X	X			(X)		X	X	X	X	X	X	X	X
Economic Base Survey	X	X	X	(X)	X	X	X	X	X	X	X	X	X	X	X
Water Resources	X	(X)	X	X		X	X	X	X	X	X	X	X	X	X
Mapping	X	(X)	X	X			X	X	X	X	X	X	X	X	X
Minerals and Geology	X	(X)	X					X	X	X	X	X	X	X	X
Mosquito Control and Allied Problems	X		X			(X)		X	X	X	X	X	X	X	X
Description of Basins and Statistical Information	(X)	X	X	X		X	X	X	X	X	X	X	X	X	X
Benefits and Costs	(X)	X	X			X	X	X	X	X	X	X		X	

LEGEND

- (X) Work Group Chairman Agency
- X Represented on Work Group

INTER-AGENCY ORGANIZATION FOR THE AWR REPORT



## Red River Basin Above Denison Dam

### Description

The Upper Red River Basin extends from eastern New Mexico, across the Texas Panhandle, to Denison Dam on the Oklahoma-Texas boundary. It embraces an area of 39,719 square miles, 891 square miles in New Mexico and the remainder divided between Texas and Oklahoma. Elevations vary from about 4,000 feet in the headwaters area in New Mexico to 600 feet at Denison Dam. The High Plains west of the 101st meridian are flat to gently rolling, with numerous shallow depressions which have no drainage outlets to streams. The Central Lowland area to the east is a rolling plain with well-developed drainage courses. Climate varies from semiarid in the west to moist subhumid in the east. Both annual and seasonal distribution of precipitation is erratic. Long periods of drought are broken by infrequent but intense rainstorms. The long summers are hot and dry, and the winters are relatively mild except during severe "northers." Wind velocity and total wind movement are characteristically high.

Agriculture, together with limited processing of agricultural products, is the predominant economic activity. Oil and gas production is important in the eastern portion. The limited industrial development is concentrated principally in Wichita Falls, Texas. Other relatively large population centers are Lawton and Ardmore, Oklahoma.

The rural and farm population of the area decreased about 40 percent in the 20-year period, 1930-50. Concurrently, urban populations have increased, particularly in the larger cities and towns. The urban growth in specific localities is traceable to new oil discoveries; to establishment of oil and gas processing plants, food processing plants, or metal fabricating units; to establishment or expansion of armed forces installations; or to development of irrigation, along with expansion of the accompanying service industries. However, despite the urban growth, total population has declined approximately 18 percent in the 20-year period, 1930-1950. Thus, a relatively large number of people have migrated to other areas to find productive employment.

### Present Development, Needs, and Potentialities

#### Availability of Water and Present Use

The protracted periods of severe drought in the 1930's and the early 1950's have emphasized the need for conservation and prudent use of water throughout this area, where the water resources which can be developed are limited by both quantity and quality considerations. East of the 98th meridian the development of facilities for supplying future water requirements of municipalities and

industrial establishments is the principal concern; development of water supplies for agricultural uses is of secondary importance since normal rainfall is generally sufficient for the moisture requirements of the principal crops. West of the 98th meridian there are both present and prospective deficiencies in municipal and industrial water supplies, and the possibility of irrigation as a factor in stabilizing and diversifying agricultural operations becomes progressively more important from east to west.

In the High Plains, ground water from the Ogallala formation has been developed to provide water supplies for the towns and industries and for irrigation of about 675,000 acres of land. Current estimates indicate that the volume of water stored in the aquifer is large in relation to present uses, although the withdrawals greatly exceed the rate at which the aquifer is recharged. Development of significant water supplies from surface sources is precluded by the low rainfall and the noncontributing character of the terrain. Thus, the potentialities for industrial activity and expansion of irrigation in the High Plains section will, in time, be limited by the magnitude of ground-water withdrawal which can be maintained.

In the Central Lowland section, both ground- and surface-water resources are utilized. Ground water now provides the water supply for most small municipal systems and for numerous small tract irrigation enterprises concentrated in three counties along the Red River in western Oklahoma. The yields of developed ground-water sources have been sufficient for the rural domestic and farmstead requirements and for numerous small towns, but the dependable yields of the sources have not been determined. The high mineral content of most ground water in this area makes it unsuitable for many industrial uses and undesirable for domestic and municipal uses. Ground-water investigations indicate that several alluvial terraces adjacent to various streams may yield sufficient potable water for nearby small communities, but no additional supplies of significant magnitude and acceptable quality can be anticipated in the interstream areas.

The larger towns and cities have developed surface-water supplies to obtain adequate quantities or, in some cases, because the surface-water quality is superior to that of the available ground water. Wichita Falls, Texas, the largest city, obtains municipal water from Lake Kickapoo. Lawton, Duncan, Chickasha, Ardmore, and numerous other towns in Oklahoma, have also developed surface supplies. All municipalities using surface supplies have experienced deficiencies or face the prospect of deficiencies in the foreseeable future. The present drought has accentuated the problem.

Opportunities for development of additional surface water supplies are limited both by the flow characteristics of the streams

and by mineralization from natural sources and pollution from municipal and industrial wastes, including oilfield wastes. All streams traversing the area between the 99th and 101st meridians are subject to varying degrees of contamination. Flows of the Wichita River, Pease River, Prairie Dog Town Fork, Salt Fork, and Elm Fork are unsuitable for municipal and industrial uses. Although North Fork and the upper Washita River waters have considerable mineral content, their over-all quality is acceptable. East of the 99th meridian, a number of tributaries to the Washita River and to the main stem of the Red River have significantly large flows of water of relatively good quality. Certain other tributaries yield large volumes of water but are contaminated by municipal and industrial wastes. Reference is made to Plate 13, Chemical Quality of Surface Waters.

Two surface impoundments have been constructed to store water for irrigation. Lake Kemp near Wichita Falls, Texas, on the Wichita River provides water for approximately 22,000 acres. The W. C. Austin Project, near Altus, Oklahoma, obtains water from the Altus Reservoir on the North Fork of Red River. Studies based on streamflows during the current drought period indicate that this reservoir will provide a dependable water supply for 27,000 acres, although the irrigation distribution system serves about 47,000 acres. In addition to the impoundments, some surface water is pumped to adjacent lands at scattered locations along streams in the Washita River Basin.

#### Municipal and Industrial Water Supply

Land use in the upper Red River Basin may be expected to continue much as at present with some intensification of agriculture in selected localities where irrigation, flood control or drainage measures are practicable. For any significant increase in employment opportunities the area must look to expansion of processing, manufacturing, and service activities.

The energy and chemicals provided by the petroleum and natural gas resources, the other minerals, and the agricultural products of the area could provide a basis for considerable industrial expansion and associated urban development in the upper Red River Basin. The extent to which such development will occur depends, in part, upon factors that have not been fully explored. These include such questions as: (1) the advantages of this area in comparison with other areas with similar resources; (2) the extent to which urban communities here can compete with larger established centers such as Oklahoma City, Amarillo, Fort Worth, Dallas, and Lubbock; and (3) the availability of transportation facilities, capital, and markets.

Should there be a significant expansion of industrial activity in the upper Red River Basin, it will be essential that a large part of the limited water supplies be developed for municipal

and industrial use rather than for agricultural purposes. Further study is needed to determine municipal and industrial water requirements and the best source of supply for many of the cities in the area. Generalized estimates made in connection with the AWR survey indicate that total municipal and industrial water requirements in the upper Red River Basin may increase by approximately 134 million gallons per day by the year 2000.

#### Irrigation, Flood Control, and Drainage

In the High Plains, soils are deep and fertile, and are highly productive when moisture conditions are favorable. Livestock grazing and production of wheat, sorghums, and other crops suitable to the climate, are the major land uses. About 675,000 acres of cropland are irrigated from ground water, and expansion of the irrigated area is continuing. Receding water levels indicate that the amount of irrigation which can be sustained by ground-water pumping will eventually decline below the present level. No significant surface-water supplies are available to supplement the ground-water developments.

East of the High Plains, an area of rough topography and relatively shallow soils extends across the Basin in a north-south band 40 to 60 miles in width. Grazing of livestock is the principal agricultural activity. A major portion of the valley lands are not sufficiently extensive or productive to warrant consideration of flood control, and deficiencies of suitable lands and water supplies preclude any significant development of irrigation.

The Central Lowland area, which constitutes the major part of the upper Red River Basin, is a rolling prairie. Here the generally productive soils and higher rainfall provide a basis for more intensive agriculture. Grazing is practiced throughout the area, but production of wheat, cotton, and grain sorghum is important. Alfalfa, cotton, and other crops are grown in irrigated areas and become increasingly important from west to east in dry-farming operations. The vagaries of climate, combined with the nature of the topography and soils, make most of the area subject to serious erosion. Productivity of the land resources of the Lowland may be increased through water use and control measures by: (1) irrigation of valley lands where soils are suitable and water supplies can be developed; (2) protection of valley lands through appropriate flood control measures; and (3) drainage of selected areas.

The recent extended drought has contributed to a growing realization throughout the Central Lowland area that irrigation is desirable to reduce the variations in production which occur under natural conditions. Although it is unlikely that irrigation will materially change the agricultural economy of the entire area, it is evident that irrigation of additional land will be undertaken. Although suitable lands and available water would permit development of about 400,000 acres, it appears that, because of cost and

other factors, only approximately 100,000 acres will be feasible for irrigation within the foreseeable future.

Some additional land can be placed in production or made more productive by installation of flood control facilities. Approximately 1,158,000 acres of land are subject to flooding. Significant agricultural flood damages occur in the Washita River Basin; and on Elm Fork and Elk, Otter, Turkey, Cache, and Beaver Creeks; and in the lower reaches of the Pease, Wichita, and Little Wichita Rivers. Floods cause damage to the towns of Fort Cobb, Chickasha, Lindsay, Pauls Valley, Waurika, and Comanche, Oklahoma; and Wichita Falls, Texas. Total annual flood damage in the sub-basin is estimated to be \$8.2 million, of which \$4.7 million is damage to crops and pasture, and \$3.5 million is damage to other property and improvements, including urban development.

Areas which have inadequate drainage for optimum agricultural production include 55,100 acres along the main stem of the Washita River and in the flood plains of Sugar, Rush, and Wildhorse Creeks; 22,800 acres along Mud and Beaver Creeks; 10,800 acres along the Wichita River; 6,700 acres along Little Wichita River; and 3,100 acres along Paradise Creek in Texas. In all, 98,500 acres in the sub-basin are classified as wetlands. Reference is made to Plate 14 for distribution of wetland areas.

#### Plan of Development

The long-range plan of development for the water resources of the upper Red River Basin would reduce property damage through flood control and flood forecasting measures and would increase the agricultural productivity of the area through irrigation, drainage, flood control, and waterflow retardation. In the plan it is recognized that the water resources should be protected from pollution and that a large part of the surface water resources which are of suitable quality should be used for municipal and industrial purposes. The elements of the plan and the potentials thereof are discussed below.

In the Washita River Basin, the previously recommended Foss and Fort Cobb Projects would supply municipal and industrial water to Anadarko, Chickasha, Clinton, and Elk City, and possibly to a number of additional smaller towns. Gracemont Reservoir on Sugar Creek and Purdy Reservoir on Rush Creek are potential sources for municipal and industrial water. The Waurika Reservoir on Beaver Creek and Scotland Reservoir on Little Wichita River offer potential sources of water supply for Lawton, Cache, Chattanooga, Hastings, and Waurika, Oklahoma; and Wichita Falls, Texas. The Randlett Reservoir on Deep Red Run would be a single-purpose, municipal and industrial water-supply project, should requirements develop in the area. Although the Mountain Park Reservoir is planned for irrigation and flood control purposes, the relatively

superior quality of the water it provides indicates that it offers one of the best potential sources of municipal and industrial water for the sub-basin.

Although the plans have not been developed, water supplies can be provided for numerous small towns which are located near streams with water of suitable quality by constructing small reservoirs to provide storage to carry over the periods of low flow. Many smaller communities can continue to secure limited water supplies from underground sources but studies are needed to determine dependable yields of such sources.

The previously recommended Foss and Fort Cobb Projects in the Washita Basin provide the most promising potentialities for irrigation development. The two projects would supply water for approximately 25,700 acres. The Mountain View Project downstream from Foss Reservoir would provide an irrigation water supply for 9,370 acres. It is estimated that 5,000 acres could be irrigated from Purdy Reservoir. The Grady County Pumping Project, which would irrigate 3,525 acres, is dependent upon the streamflow regulation provided by Foss, Fort Cobb, and Mountain View Projects.

The Mangum Project on the Salt Fork would furnish supplementary water supply necessary for operation of the 47,800-acre W. C. Austin Project or water to irrigate new lands along the west side of Salt Fork in Jackson County. Mountain Park Reservoir on Otter Creek can be utilized to irrigate about 9,000 acres of highly productive lands. However, the extent to which this project should be developed for irrigation depends upon whether all or part of the dependable yield should be utilized for municipal and industrial purposes. The Waurika Project would provide for irrigation of 2,600 acres.

The authorized program of waterflow retardation and erosion prevention in the Washita River Basin and previously recommended local protection for Pauls Valley, Oklahoma, and flood control storage in the previously recommended Foss and Fort Cobb Reservoirs in the same Basin are included in the long-range plan for the control of floods in the area. In addition, the plan includes 400 waterflow retardation structures on other tributaries of the Red River, 3 local flood protection projects, 13 reservoirs and improved flood forecasting measures. The waterflow retardation structures are planned to reduce flood damages resulting from the frequent floods in the tributary areas. The local flood control projects, involving levees and channel improvement, will provide protection for Comanche, Waurika, and a rural area on Deep Red Run, all in Oklahoma. Flood control storage is provided in the Mountain Park Reservoir on Otter Creek, Waurika Reservoir on Beaver Creek, Oklahoma; and in Scotland Reservoir on Little Wichita River, Texas. Modification of the existing Lake Wichita in Texas is also included

in the long-range plan. The Gainesville Reservoir on Red River would aid the existing Denison Dam (Lake Texoma) in reduction of flood losses on Red River. Six reservoirs in the Washita Basin are combined with two previously recommended reservoirs in a multiple-purpose plan to provide a major reduction in damages along Washita River and tributaries below the dam sites. It is estimated by the Corps of Engineers and the Department of Agriculture that the average annual primary flood control benefits from the plan would approximate \$5,095,000, of which \$3,409,000 is damages prevented and \$1,686,000 is attributed to changed land use. In addition, the Department of Agriculture estimates the average annual damages prevented by land treatment to be \$1,587,000.

The plan includes drainage facilities for 39,625 acres of land along the Washita River and its tributaries, about 72 percent of the total wetland area in that locality; for 9,900 acres on Mud Creek, about 67 percent of the wetland area; and for 7,100 acres on Beaver Creek, about 89 percent of the wetland area. Drainage works would consist generally of group and on-farm facilities discharging directly into adjacent streams. Flood control is prerequisite to drainage improvement in all these areas.

The plan includes hydroelectric generating facilities at the Gainesville Reservoir site, located on the Red River just above Lake Texoma. The Gainesville power plant with an installed capacity of 100,000 kilowatts would assist in meeting the future power needs of the area. The Denison Reservoir project is discussed in the following section on the Red River Basin Below Denison Dam.

The specific elements of the plan and pertinent information relating to each are shown in Table 6, and the locations of the major water use and control projects are shown on Plate 10, Red River Basin Above Denison Dam. A description of each is given in Section 2 of Part II, entitled "Water Resources Project Data."

Table 6 - Long-range Water Use and Control Plan  
Red River Basin above Denison Dam

Project or program	Stream	Purposes	Total construction cost (\$1,000)	Benefit-cost ratio
<u>Present Development</u> (Actual cost unless otherwise noted)				
<u>Reservoirs</u>				
W. C. Austin (Altus Reservoir) Project	North Fork of Red River, Oklahoma	Water supply, irrigation & flood control	12,858.0	
Lake Kemp	Wichita River, Texas	Water supply & irrigation	1,937.0	
Lake Kickapoo	Little Wichita River, Texas	Water supply	Not available	
Lake Wichita	Holliday Creek, Texas	Water supply & irrigation	Not available	
<u>Other</u>				
51 Waterflow-retardation structures	Washita River Basin, Okla.	Waterflow retardation	1,599.0	
<u>Previously Authorized and Recommended Projects</u> (Current prices as noted)				
<u>Reservoirs</u>				
Foss <u>1/</u>	Washita River, Oklahoma	Irrigation, water supply & flood control	22,032.5	
Fort Cobb <u>1/</u>	Pond Creek, Oklahoma	Irrigation, water supply & flood control	15,688.5	
<u>Local Protection Projects</u>				
Pauls Valley, Oklahoma, Levee	Washita River, and Rush Creek, Okla.	Flood control	2,298.0	

1/ Unit of Washita River Multiple-Purpose Plan for optimum development in Washita River Basin.

Table 6 -- Long-range Water Use and Control Plan  
Red River Basin above Denison Dam (cont'd)

Project or program	Stream	Purposes	Total construction cost (\$1,000)	Benefit-cost ratio
<u>Previously Authorized and Recommended Projects (cont'd)</u> (Current prices as noted)				
<u>Other</u>				
588 Waterflow-retardation structures	Washita River Basin, Okla.	Waterflow retardation	31,782.4	Projected prices
<u>Improvements Added in AWR Studies</u> (Projected prices unless otherwise noted)				
<u>Reservoirs</u>				
Sauls	Quitaque Creek, Texas	Water supply	6,050.8	<u>2/</u>
Mangum	Salt Fork, Oklahoma	Irrigation	14,258.0	1.0
Mountain Park	Otter Creek, Oklahoma	Irrigation & flood control	7,182.0	0.7
Randlett	Deep Red Run, Oklahoma	Water supply	9,098.0	<u>2/</u>
Waurika	Beaver Creek, Oklahoma	Flood control, water supply & irrigation	17,078.0	<u>2/</u>
Scotland	Little Wichita River, Texas	Flood control & water supply	12,109.0	<u>2/</u>
Gainesville	Red River, Oklahoma & Texas	Flood control & power	99,169.0	<u>3/0.3</u>
Mountain View <u>1/</u>	Washita River, Oklahoma	Flood control & irrigation	16,492.0	<u>4/</u>

1/ Unit of Washita River Multiple Purpose Plan for optimum development in the basin.

2/ Exclusion of water-supply benefits precludes comparison with costs, which include water supply features.

3/ Evaluation based on reservoir operating as an adjunct to existing Denison Project and utilizing primary power benefits based on alternative private steam-electric stations and Federal hydrotransmission, with taxes foregone resulting from Federal construction considered as an economic cost.

4/ Exclusion of water-supply benefits in reservoirs of the Multiple Purpose Plan precludes comparison with costs, which include water-supply features.

Table 6 -- Long-range Water Use and Control Plan  
Red River Basin above Denison Dam (cont'd)

Project or program	Stream	Purposes	Total construction cost (\$1,000)	Benefit-cost ratio
<u>Improvements Added in AWR Studies (cont'd)</u> (Projected prices unless otherwise noted)				
<u>Reservoirs (cont'd)</u>				
Rainy Mountain <u>1/</u>	Rainy Mountain Creek, Okla.	Flood control	5,433.0	<u>4/</u>
Gracemont <u>1/</u>	Sugar Creek, Oklahoma	Flood control & water supply	6,596.0	<u>4/</u>
Chickasha <u>1/</u>	Little Washita River, Okla.	Flood control	7,249.0	<u>4/</u>
Purdy <u>1/</u>	Rush Creek, Oklahoma	Flood control, irrigation & water supply	10,503.0	<u>4/</u>
Hennepin <u>1/</u>	Wildhorse Creek, Okla.	Flood control	15,856.0	<u>4/</u>
Lake Wichita (Modification)	Holliday Creek, Texas	Flood control & conservation	2,703.0	0.9
<u>Local Protection Projects</u>				
Channel improvement	Deep Red Run, Oklahoma	Flood control	4,281.0	0.6
Channel improvement and levee	Beaver Creek, Waurika, Okla.	Flood control	269.3	1.4
Channel improvement	Cow Creek, Comanche, Oklahoma	Flood control	668.0	0.9
<u>Other</u>				
Local drainage	Mud Creek, Oklahoma	Drainage	193.6	2.1
Local drainage	Beaver Creek, Oklahoma	Drainage	138.9	6.8

1/ Unit of Washita River Multiple Purpose Plan for optimum development in the basin.

4/ Exclusion of water-supply benefits in reservoirs of the Multiple Purpose Plan precludes comparison with costs, which include water supply features.

Table 6 - Long-range Water Use and Control Plan  
 Red River Basin above Denison Dam (cont'd)

Project or program	Stream	Purposes	Total construction cost (\$1,000)	Benefit-cost ratio
<u>Improvements Added in AWR Studies (cont'd)</u> (Projected prices unless otherwise noted)				
<u>Other (cont'd)</u>				
Local drainage <u>1/</u>	Washita River, Oklahoma	Drainage	869.5	<u>5/6.9</u>
Irrigation Pumping <u>1/</u>	Grady Co., Washita River, Oklahoma	Irrigation	567.0	1.3
Non-project irrigation <u>6/</u>	Oklahoma	Irrigation		

1/ Unit of Washita River Multiple Purpose Plan for optimum development in the basin.

5/ The B/C ratio is based upon drainage benefits which are inseparable from flood-control benefits. Apportionment of drainage benefits among related drainage and flood control elements of the system has not yet been determined.

6/ Not shown on plates.

Table 6 - Long-range Water Use and Control Plan  
 Red River Basin above Denison Dam (cont'd)

Number of structures	Stream	Purpose	Total construction cost (\$1,000)	Benefit-cost ratio
<u>Waterflow-retardation Structures</u> (Projected prices unless otherwise noted)				
9	Minor tributaries of Red River, Texas	Waterflow retardation throughout	528.8	
8	Prairie Dog Town Fork, Lebos Creek		440.0	
10	Salt Fork, Turkey Creek		563.0	
5	Bitter Creek		198.2	
1	Elm Fork, Fish Creek		256.7	
9	Elm Fork, Haystack Creek		573.3	
24	Elm Fork, Remaining area		1,773.3	
112	Elk Creek		4,427.9	
46	Elk Creek, Otter Creek		2,009.7	
20	Elk Creek, Stinking Creek		889.3	
54	Deep Red Run & tributaries		3,608.8	
22	Beaver Creek, above Waurika Reservoir		3,541.3	
7	Beaver Creek, Cow Creek		1,183.8	
40	Mud and Walnut Creeks		2,990.0	
34	Minor tributaries of Red River, Okla.		1,989.3	